Semana de Congresos y Jornadas Nacionales

Mesa Redonda

Por un niño sano en un mundo mejor

Errores en el manejo de la hidratación en el paciente crítico

Tema: Descompensación diabética

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Caso clínico:

- Varón de 7 años de edad (Peso: 20 Kg)
- 2 semanas de evolución de descenso de peso, astenia, adinamia y dificultad respiratoria en las últimas 72 hs
- Se lo valora taquipneico con palidez generalizada y alteración del sensorio

Caso clínico:

	Ingreso
Hto (%)	
Urea (mg/dl)	
Creatinina (mg/dl)	
Glucemia (mg/dl)	**456**
Iono (mEq/L)	140/3,5
EAB (pH/pCO2/Bic)	**6,99/15/2,5**
Osm calculada (mOsm/L)	312
Na corregido (mEq/L)	147,12

- Expansión con sol fisiológica, luego PHP.
- Corrección con bicarbonato
- Intubación / ARM < 24 hs
- Derivación

Caso clínico:

	Ingreso	Hora 0
Hto (%)		32
Urea (mg/dl)		16
Creatinina (mg/dl)		0,56
Glucemia (mg/dl)	456	310
Iono (mEq/L)	140/3,5	145/3,7/114
EAB (pH/pCO2/Bic)	6,99/11/2,5	**7,10/10/3,3**
Osm calculada (mOsm/L)	312	314,62
Na corregido (mEq/L)	147,12	149,2

- Expansión con sol fisiológica
- Laboratorio:

  (AR: 27,7 (Δ: 18) / Δ Cl: + 6)
- Nuevas dos expansiones con sol fisiológica
- PHP 4000ml/m^2/75/40

  (Ø 2,3 mg/kg/min)

Caso clínico:

	Ingreso	Hora 0	Hora 4	Hora 6
Hto (%)		32		
Urea (mg/dl)		16		
Creatinina (mg/dl)		0,56		
Glucemia (Mg/dl)	456	310	287	189
Iono (mEq/L)	140/3,5	145/3,7/114	**138**/3,5/112	139/**2,6**
EAB (pH/pCO2/Bic)	6,99/11/2,5	7,10/10/3,3	**7,06/10,3/2,8**	7,19/19,4/,7,1
Osm calculada (mOsm/L)	312	314,62	**298,9**	293,7
Na corregido (mEq/L)	147,12	149,2	**141,74**	140,8

Hora 4: (ΔAR: 15) / Δ Cl: + 8,5)
Nueva expansión + PHP
Inicia insulina 0,1U/kg/hora

Hora 6: Nueva expansión
PHP 4000 ml/m^2/75/40

Caso clínico:

	Ingreso	Hora 0	Hora 4	Hora 6	Hora 11
Hto (%)		32			
Urea (mg/dl)		16			
Creatinina (mg/dl)		0,56			
Glucemia	456	310	287	189	**39**
Iono (mEq/L)	140/3,5	145/3,7/114	138/3,5/110	139/2,6/	**134**/**2.3**/108
EAB (pH/pCO2/Bic)	6,99/11/2,5	7,10/10/3,3	7,06/10,3/2,8	7,19/19,4/,7,1	7,30/23,7/11,4
Osm calculada (mOsm/L)	312	314,62	298,9	293,7	**272,6**
Na corregido (mEq/L)	147,12	149,2	141,74	140,78	**134**

Somnoliencia. Glasgow 13/15
TAC y FO normal

Controversias en el manejo de la CAD…

Complicaciones de la terapia:

- Rehidratación Inadecuada
- Hipoglucemia
- Hipokalemia
- Acidosis Hiperclorémica
- Edema Cerebral / Muerte

1. **Diagnóstico**
2. **Líquidos: Calidad y Cantidad**
3. **Corrección de Bicarbonato**
4. **Insulina**

1. **Diagnóstico**
2. **Líquidos: Calidad y Cantidad**
3. **Corrección de Bicarbonato**
4. **Insulina**

1. Diagnóstico:

- Hiperglucemia (>200 mg/dl)
- pH venoso <7.3 o bicarbonato <15 mmol/L
- Cetonemia y cetonuria.

- Leve: pH venoso <7.3 o bicarbonato <15 mmol/L
- Moderada: pH <7.2, bicarbonato <10 mmol/L
- Severa: pH <7.1, bicarbonato <5 mmol/L

ISPAD Clinical Practice Consensus Guidelines 2009

Pediatric Diabetes 2009: 10(Suppl. 12): 118–133

1. Diagnóstico:

- Hiperglucemia (>200 mg/dl)
- pH venoso < 7.3 o bicarbonato < 15 mEq/L
- Cetonemia y cetonuria.

Test que detecten niveles de ß-hidroxibutarato sérico (>3 mmol/L)

Pediatric Diabetes 2014: 15: 277–286

1. **Diagnóstico**
2. **Líquidos: Calidad y Cantidad**
3. **Corrección de Bicarbonato**
4. **Insulina**

2. Líquidos:

- Aún no existe la solución ideal
- Isotónicos las 1ras 4-6 horas
- Líquidos totales: 1,5 a 2 veces los Requerimientos Basales (incluída la renimación)

ISPAD Clinical Practice Consensus Guidelines 2009

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Pediatric Diabetes 2014: 15: 277–286

Caso clínico:

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Iono (mEq/L)	140/3,5	145/3,7/114	138/3,5/110	139/2,6
EAB (pH/pCO2/Bic)	6.99/11/2,5	7,15/10/3,3	7,06/10,3/2,8	7,19/19,4/,7,1
Osm calculada (mOsm/L)	312	314,62	298,9	293,7
Na corregido (mEq/L)	147,12	149,2	141,74	140,8

6 expansiones (3000 ml/m2) + PHP 4000 ml/m2/75/40

Ascenso proporcional del sodio plasmático

Descenso de la glucemia

Caso clínico:

	Ingreso	Hora 0	Hora 4	Hora 6	Hora 11
Hto (%)		32			
Urea (mg/dl)		16			
Creatinina (mg/dl)		0,56			
Glucemia	456	310	287	189	**39**
Iono (mEq/L)	140/3,5	145/3,7/114	138/3,5/110	139/2,6/	**134/2.3/**108
EAB (pH/pCO2/Bic)	6.99/80/2,5	7,15/10/3,3	7,06/10,3/2,8	7,19/19,4/,7,1	7,30/23,7/11,4
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2. Líquidos:

Table 2. Overview of fluid regimens used in the FLUID Trial (adapted from reference 51)

	Protocol A1	Protocol A2	Protocol B1	Protocol B1
Assumed fluid deficit	10% of body weight	10% of body weight	5% of body weight	5% of body weight
Initial fluid bolus	10 cc/kg of 0.9% saline	10 cc/kg of 0.9% saline	10 cc/kg of 0.9% saline	10 cc/kg of 0.9% saline
Additional fluid bolus	10 cc/kg of 0.9% saline	10 cc/kg of 0.9% saline	No additional bolus	No additional bolus
Deficit replacement	½ deficit + maintenance fluids over initial 12 h; remaining deficit + maintenance fluids over next 24 h	½ deficit + maintenance fluids over initial 12 h; remaining deficit + maintenance fluids over next 24 h	Deficit + maintenance fluids evenly over 48 h	Deficit + maintenance fluids evenly over 48 h
Fluid used for deficit replacement	0.45% saline	0.9% saline	0.45% saline	0.9% saline

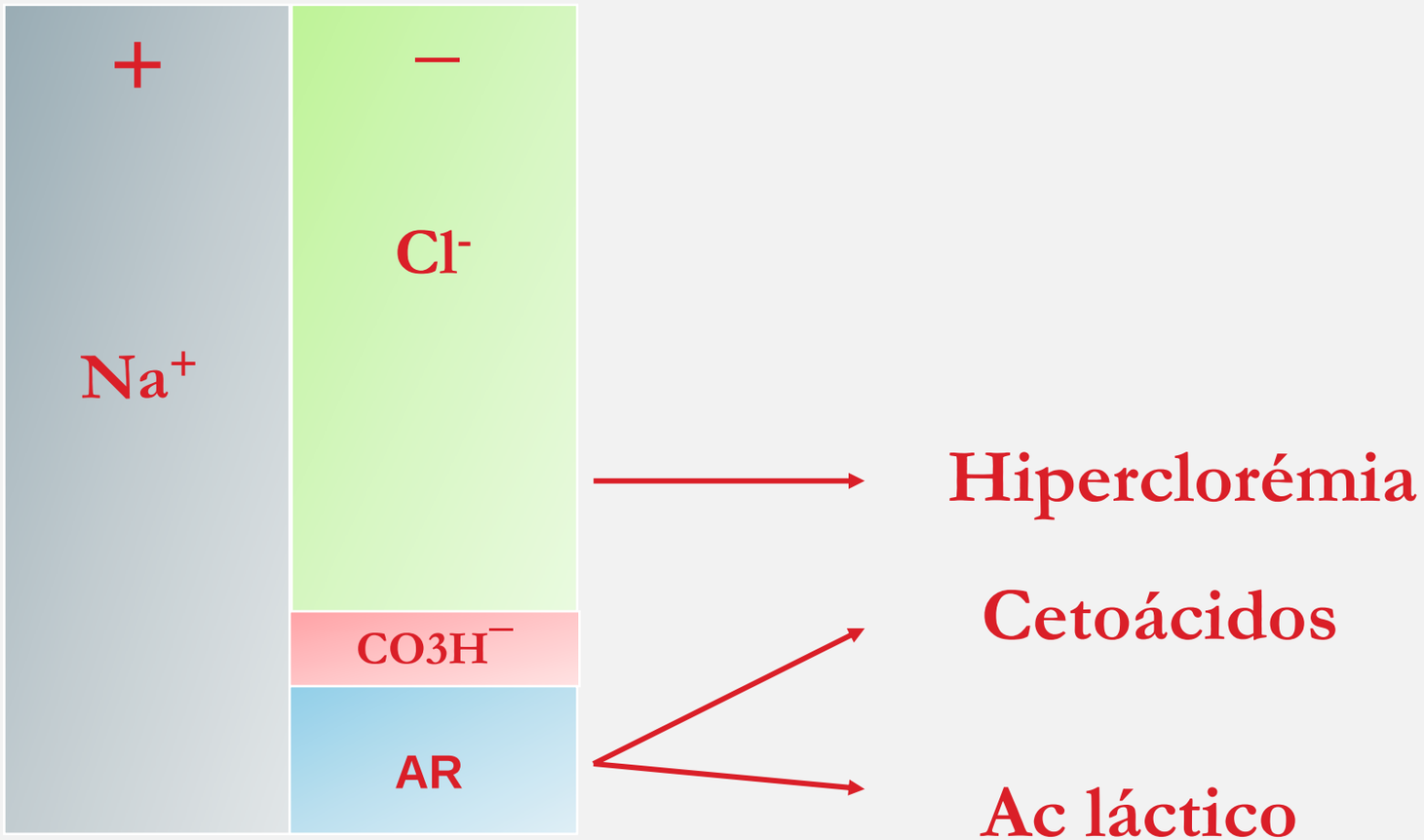
FLUID, Fluid Therapies Under Investigation in DKA.
Protocol A1 more rapid rehydration with 0.45% saline; protocol A2 more rapid rehydration with 0.9% saline; Protocol B1 slower rehydration with 0.45% saline; and protocol B2 slower rehydration with 0.9% saline.

Pediatric Emergency Care Applied Research Network (PECARN)

Pediatric Diabetes 2014: 15: 277–286

1. **Diagnóstico**
2. **Líquidos: Cantidad y Calidad**
3. **Corrección de Bicarbonato**
4. **Insulina**

3.Acidosis:



Caso clínico:

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Hto (%)		32			
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Osm calculada (mOsm/L)	312	314,62	298,9	293,7	272,6
Na corregido (mEq/L)	147,12	149,2	141,74	140,78	134
AR/ΔAR		**27,7/18**	**23,2/15**		**14,6/3,6**
ΔCl^-		**6**	**8,5**		**8**

Chua *et al. Annals of Intensive Care* 2011, **1**:23
http://www.annalsofintensivecare.com/content/1/1/23

Annals of Intensive Care
a SpringerOpen Journal

REVIEW Open Access

Bicarbonate in diabetic ketoacidosis - a systematic review

Horng Ruey Chua[1], Antoine Schneider[1] and Rinaldo Bellomo[1,2*]

Conclusions

The evidence to date does not support the use of bicarbonate administration for the emergent treatment of DKA, especially in the pediatric population, in view of possible clinical and physiological harm and the lack of clinical or sustained physiological benefits. There also is insufficient evidence to justify the recommendation of bicarbonate administration in more extreme acidemia of pH < 6.90. Future research should focus on the use of more balanced and physiological resuscitation fluids with buffering capacity, in the modern context of DKA management, with the goal of reducing the component of hyperchloremic acidosis in DKA while minimizing the risk of CSF acidosis and associated CE.

1. **Diagnóstico** Δ
2. **Líquidos: Cantidad y Calidad**
3. **Corrección de Bicarbonato**
4. **Insulina**

4. Insulina:

- Consenso infusión contínua endovenosa de insulina a 0,1 U/kg/hora
- Inicio luego de la 1er hora de reanimación
- Evitar caída rápidas de la glucemia

ISPAD Clinical Practice Consensus Guidelines 2009

Pediatric Diabetes 2009: 10(Suppl. 12): 118–133

Pediatric Diabetes 2014: 15: 277–286

Table 1. Studies comparing insulin infusion doses ≤0.05 U/kg/h with 0.1 U/kg/h

Study	Aim	Design	Endpoint	Results and conclusions
Puttha et al. (31)	To compare 0.05 U/kg/h IV insulin infusion for initial treatment of DKA with 0.01 U/kg/h.	Retrospective observational; data from five centers: 41 vs. 52 episodes.	At 6 h, fall in BG and rise in pH similar: 11.3 vs. 11.8 mM and 0.13 vs. 0.11.	Changes comparable between doses in relation to: severity of initial acidosis, newly diagnosed or aged <5 yr. After adjustment for other clinical and biochemical covariates, insulin dose was unrelated to change in pH and BG levels at 6 h after admission. Safety comparisons (especially abnormal Glasgow Coma Score) inconclusive.
Al Hanshi et al. (32)	To compare insulin infusion at 0.05 vs. 0.1 U/kg/h in children admitted in ICU.	Retrospective observational; 34 children received 0.1 vs. 0.05 U/kg/h in 33 children; 0.05 U/kg/h children younger (25 vs. 62 months).	Assessed parameters 12 h after commencing insulin infusion.	More gradual reduction in effective plasma osmolality over first 12 h because PG decreased more slowly and plasma sodium concentration increased faster. Both groups had satisfactory improvements in acidosis and ketosis, and had similar length of stay in ICU. Smaller dose may make it easier to gradually lower effective plasma osmolality.
Kapellen et al. (33)	To compare insulin infusion at 0.025 U/kg/h vs. standard 0.1 U/kg/h (0.05 U/kg/h <5 yr).	Retrospective, observational; 23 treated in ICU of center A, mean age 8.9 yr (low dose) vs. 41 in ICU of center B, mean age 13.5 yr, (standard dose).	Follow-up to 48 h. Time to normalize pH (≥7.3) and BG; occurrence of hypoglycemia (<56 mg/dL, 3.1 mM) or hypokalemia <3.2 mmol/L.	Standard dose resulted in slightly shorter duration of acidosis (8 vs. 6.5 h) and faster normalization of BG, <11 mmol/L (18 vs. 10.5 h). Similar low rates of hypoglycemia during first day. Center B, one case of cerebral edema with cerebral infarction. In first 12 h, patients in center B received twice as much fluid as in center A; 70% of patients in center A and 17% in center B received HCO_3. Cumulative insulin dose until pH normalized 0.21 vs. 0.48 U/kg, center A vs. B, respectively.
Noyes et al. (23)	To assess clinical application of near patient testing device for capillary BOHB measurement in evaluating a new endpoint for IV insulin. Starting insulin dose 0.03–0.05 U/kg/h (median 0.045, range 0.02–0.1).	Prospective study of 40 DKA episodes in 25 subjects 1–14 yr. Evaluated two treatment endpoints in same subjects: (i) pH >7.3 + urine ketone free; (ii) pH >7.3 + two successive hourly BOHB values <1 mmol/L.	35 of 40 episodes, ICP completed without significant variation; 28 episodes followed to negative urine ketones. Endpoint A reached after 17 h (4–39); endpoint B was reached after 28 (14–64) h. Median lag was 11(1–36) h. For 59 paired venous samples (excluding samples with lab BOHB >6 mM) POC and laboratory BOHB $y = 0.92x - 0.05$, $r^2 = 0.94$, mean bias −0.25 mmol/L).	Serial measurements of BOHB allow a new simple earlier endpoint for IV insulin therapy.

BG, blood glucose; BOHB, ß-hydroxybutyrate; DKA, diabetic ketoacidosis; ICU, intensive care unit; IV, intravenous; ICP, integrated care pathway; PG, plasma glucose.

Dosis menores (0,05 U/kg/hora):

- Igual efectividad
- Mayor seguridad

Conclusiones: