



Clinical Guidance

Paediatric Critical Care: Diabetic Ketoacidosis (DKA)

Summary

This guideline is for use when treating **severe DKA** (pH <7.1 or bicarb <5mmol/L, blood glucose > 11mmol/L and blood ketones >3mmol/L) **and** there are concerns the child has a reduced GCS, shock or other requirement for critical care. NICE and BSPED guidance liberalised fluids from 2020 based on the PECARN FLUID trial which showed equivalence between liberal and more restrictive fluid regimes. This trial excluded the sickest patients so concerns remain that critically ill patients are at an increased risk of cerebral oedema.

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Relevant external law,	NICE guidance									
regulation, standards										
This clinical guideline has been produced by the South Thames Retrieval Service (STRS) at Evelina London for nurses, doctors and ambulance staff to refer to in the emergency care of critically ill children. This guideline represents the views of STRS and was produced after careful consideration of available evidence in conjunction with clinical expertise and										

experience. The guidance does not override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient.

Date	Change details, since approval	Approved by
26/09/24	Changed fluid rate and corrected sodium to align with NICE guidance. Expert consensus to reduce fluid by 50% if concerns of neurological deterioration/ concerns of cerebral oedema. Amended anion gap calc. Change in inotropes away from dopamine to adrenaline /noradrenaline	ELCGC Feb 25

Paediatric Critical Care: Diabetic Ketoacidosis



The principles of management of DKA are fluid replacement and insulin therapy with the aim to correct dehydration and ketoacidosis, normalise blood glucose levels whilst avoiding complications like cerebral oedema and electrolyte disturbances.

$\pmb{SHOCK} \rightarrow \pmb{\mathsf{CALL}} \; \pmb{\mathsf{STRS}}$

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Prolonged/delayed CRT and tachycardia are expected in DKA because of vasoconstriction, hypocapnia ¹ or acidosis so should NOT be used to assess shock or as rationale to give fluid boluses

Weak / low volume pulses, hypotension, reduced urine output and elevated lactate are more reliable markers of shock

- 10mL/kg bolus of 0.9% sodium chloride / Plasmalyte
- Cautious assessment if further bolus is needed
 Avoid excessive fluid to prevent cerebral oedema
- If signs of shock persist after 2 x 10mL/kg boluses, consider early use of peripheral inotropes:
 - If concerns of poor cardiac function: Adrenaline infusion
 - If concerns of vasoplegia /sepsis: Noradrenaline infusion
- Investigate cause of shock: If concerns of sepsis (fever/ hypothermia, raised CRP) follow sepsis guideline ¹

FLUID REPLACEMENT AND INSULIN

Fluid/Insulin as per BSPED² unless concerns of: low GCS or CorrNa drop

If glucose drops too quickly without sodium rising then osmolarity drops risking cerebral oedema. Calculate corrected sodium (CorrNa) 4 hourly:

Corrected Sodium (Na) = Plasma Na + (0.3 x (Glucose - 5.6))

If CorrNa falls >5 mmol/L in 4 hours, Reduce fluid rate by 50%

Diagnose if: fall in GCS/ new headache/ confusion/ unequal pupils / focal neurological signs

1. Urgent administration 2.7% sodium chloride

[3mL/kg over 10minutes, repeat dose if no neuro improvement] [If 2.7% NaCl not available, use 20% mannitol 0.5-1g/kg over 10 minutes]

- 2. Reduce fluid rate by 50%
- 3. CT head + contrast (exclude venous sinus thrombosis) if neuro doesn't improve with 2.7% NaCl
- 4. Avoid intubation and ventilation unless the patient is not protecting their airway or is hypoventilating
 - Ensure patient not hypovolaemic on anaesthetic induction (can use hypertonic saline for volume)
 - pH may worsen once ventilated as goal is to slowly increase pCO₂ to low-normal range (arterial CO2 4-5 kPa), avoiding sudden changes in cerebral flow from hypocapneic vasoconstriction.

KETONES AND PROLONGED METABOLIC ACIDOSIS

pH often remains low as hyperchloraemia (partially due to fluid therapy) masks resolution of ketoacidosis. Use blood ketones as a guide to measure effectiveness of DKA therapy

• It is rare to need <a>0.2 units/kg/h insulin infusion- If blood ketones remain high, check insulin prescription/delivery are correct and consider sepsis.

Calculate base deficit due to chloride = (Sodium - Chloride) - 35 to differentiate if acidosis is due to hyperchloraemia or unmeasured acids that need to be considered

1.<u>NICE (2015, updated 2023). Diabetes (type 1 and type 2) in children and young people: diagnosis and management</u> 2.British Society for Paediatric Endocrinology and Diabetes (2021). BSPED Guideline for the Management of Children and Young People under the Age of 18 Years with DKA -2021. [online] Available at: https://www.bsped.org.uk/media/1959/dka-guidelines.pdf. 3.PECARN DKA FLUID Study Group. Clinical Trial of Fluid Infusion Rates for Pediatric Diabetic Ketoacidosis. N Engl J Med. 2018 Jun 14;378(24):2275-2287. 4. Hillier TA. Hyponatremia: evaluating the correction factor for hyperglycemia. Am J Med. 1999; 106(4):399-403.

MONITORING

- Vitals, GCS Neuro obs 1/2 hourly
- Blood glucose hourly
- -add glucose to fluids if <14mmol/L
- Blood gas, ketones 2 hourly
- Corrected Na 4 hourly
- Electrolytes, phosphate 6 hourly

HYPOKALAEMIA

Patients have normal/high K+ on presentation which falls due to insulin

- Maintenance fluid:Max potassium of 40mmol/L
- ECG changes: Nil, ST-segment depression, prominent U-waves
- Enteral potassium if no central access (NG or encourage oral intake)
- If Potassium < 2.5mmol/L may need to briefly pause insulin infusion
- If severe hypokalaemia (<2mmol/L) then call STRS and site central line (increased risk of thrombosis as hypercoagulable state)

CEREBRAL OEDEMA RISK FACTORS

- Younger children (especially < 2 years)
- pH < 7.1 severe DKA¹
- pCO2 < 2Kpa at presentation
- Elevated Urea¹
- >40mL/kg fluid in the first hour
- First 24 hours of DKA therapy
- Hyperventilation post intubation

Date:	Date: DKA: Electrolyte												e and Blood Gas Monitoring Sheet												
Demographics												Corrected Na = Plasma Na + (0.3 x (Glucose - 5.6) Base Deficit Chloride = Na - Cl - 35													
Surname First Name										_															
Date of Birth Hospital No									_	Anion Gap (mEq/L) = Na + K – Cl – Bicarb															
Known Diabetic D Age Weight (kg)														Pleas	se calc	ulate e	every 2	-4 hou	rs						
Time	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	
Total IV fluid																									
Total IV fluid																									
mL/h																									
0.9% sodium																									
chloride																									
Bag 2 (mL/h)																									
chloride &																									
10% glucose																									
(mL/kg/h)																									
Insulin Dose (units/kg/h)																									
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Glucose (mmol/L)																									
Sodium (Na)																									
Potassium (K)																									
Chloride (Cl)																									
pH pCO ₂																									
HCO3 BE																									
Ketones																									
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Phosphate																									
Urea/ Creatinine																									
Calculated p	aramet	ers (cal	culate 2	2-4 hou	rly)			1							1	1		1							
Sodium																									
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Anion Gap		<u> </u>	<u> </u>					<u> </u>																<u> </u>	
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