Health Education Thames Valley

DIABETIC KETOACIDOSIS

MODULE: ENDOCRINOLOGY / METABOLIC

TARGET: ALL PAEDIATRIC TRAINEES; NURSING STAFF

BACKGROUND:

DKA occurs when a relative or absolute lack of insulin leads to the inability to metabolise glucose. This leads to hyperglycaemia, osmotic diuresis, and dehydration.

In around one-in-four cases, DKA presents in people who were previously unaware they had diabetes. DKA accounts for around half of all diabetes-related hospital admissions in people with type 1 diabetes.

Whereas delay in diagnosis is the major cause of DKA in previously unrecognized disease in younger children, omission of insulin is the leading cause of recurrent DKA, most prevalent among adolescents. In this group, some 5% of patients account for >25% of all admission for DKA.

The Royal College of Paediatrics and Child Health (RCPCH) has set standards for training; by the completion of level one training, all trainees are expected to be able to initiate therapy in a child presenting with Diabetic Ketoacidosis.

INFORMATION FOR FACULTY

LEARNING OBJECTIVES

At the end of the sessions participants should be able to:

1. Recognise symptoms and signs of DKA
2. Accurately assess degree of dehydration
3. Prescribe appropriate fluid and electrolyte replacement
4. Appropriately manage insulin infusion
5. Understand principles to minimise risk of cerebral oedema
6. Appropriately manage cerebral oedema if occurs

SCENE SETTING

Location:	Paediatric Assessment Unit or Emergency Department		
Expected duration of scenario:	15 mins	Expected duration of debriefing:	30 mins

EQUIPMENT AND CONSUMABLES

Mannequin (child)
Monitoring
Resuscitation trolley
O_2 facemask
Bag and mask
IV cannula and sticker fixation
Drug chart
Internet access for BPSED fluid calculator
DKA trust guidelines
Fluids:
- 0.9% saline
- 0.9% saline with 10/20/40 mmolKCl
- 0.45% saline + 5/10% dextrose
Insulin infusion (actrapid) 50 units in 50ml
Mannitol 0.5g/kg
BPSED fluid calculator (if requested – see appendix 4)
SORT Emergency drug chart (if requested – see appendix 5)

PERSONNEL-IN-SCENARIO

1 x ST1-3 trainee *and/or*
1 x ST4-8 trainee
1 x nurse (faculty or participant)
1 x mother (faculty)

PARTICIPANT BRIEFING

You have been asked to review two-year-old Freya, who has been referred by her GP with a history of vomiting, pallor and floppiness. She is tachypnoeac and tachycardic. Could this be pneumonia or another intercurrent infection?

FACULTY BRIEFING

'VOICE OF THE MANIKIN' BRIEFING

You are two years old. You initially respond to voice, by calling out 'mummy, mummy'. If cerebral oedema develops, become quieter and gradually unresponsive.

IN-SCENARIO PERSONNEL BRIEFING (MOTHER)

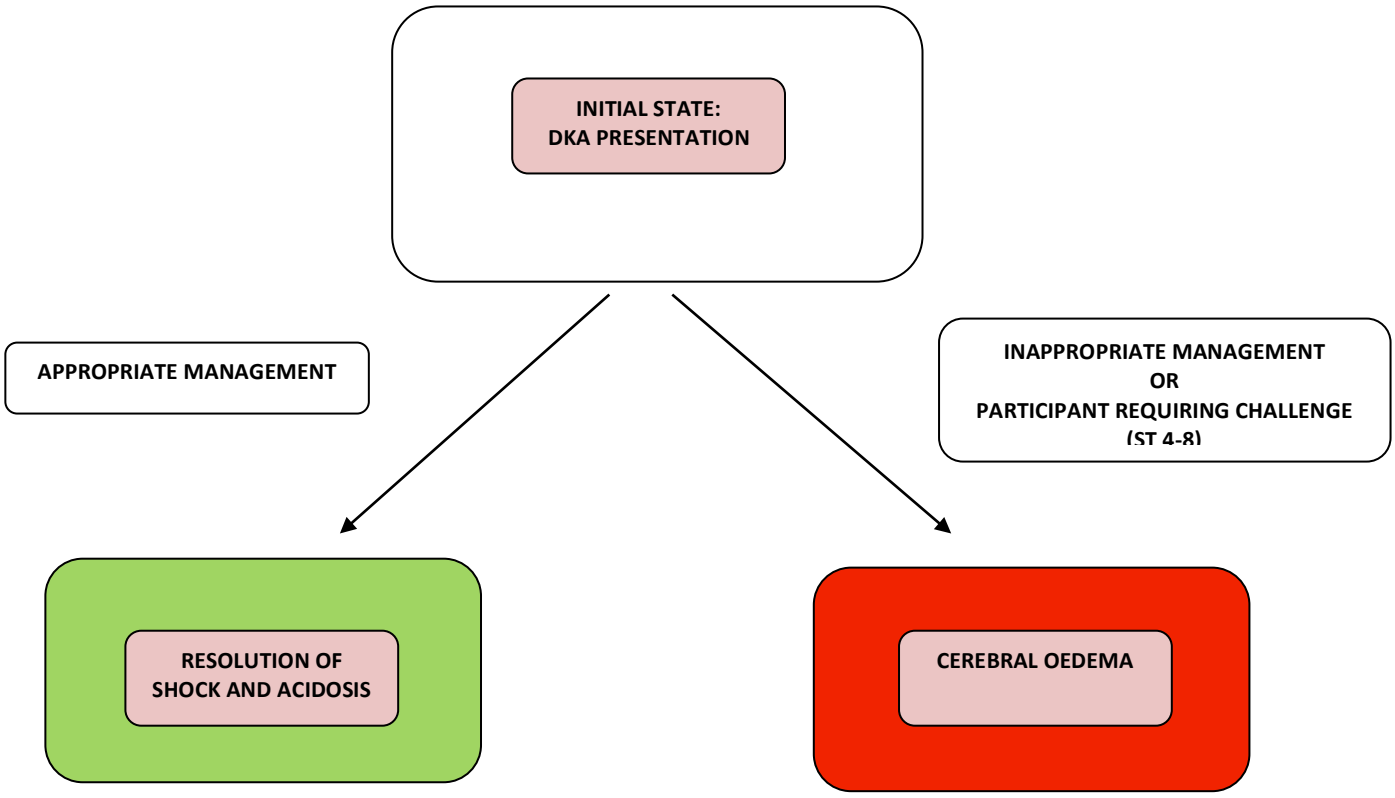
Freya is two years old and has been vomiting for 24 hours. You have noticed that she looks pale and is irritable. She hasn't had a fever, cough, or diarrhoea. You wonder if she might have a tummy bug because she has been vomiting.

If questioned: she is having plenty of wet nappies. You have also noticed over the past 3 weeks that she is drinking lots and has been losing weight.

IN-SCENARIO PERSONNEL BRIEFING (NURSE)

Two-year-old Freya has been brought in by her mother with a history of vomiting for 24 hours. You are worried about her because she has prolonged capillary refill, is tachycardic and tachypnoaec, and overall is floppy and slightly drowsy.

CONDUCT OF SCENARIO



INITIAL STATE: DKA PRESENTATION

VITAL SIGNS					
Rhythm	SR	**HR**	169	**BP**	80 / 45
Resp rate	45	**SaO_2**	94%	**$ETCO_2$**	
Temp	37.5	**AVPU**	A (GCS 14/15)	**Pupils**	4 ERL
Other	Weight = 15kg				
ASSESSMENT					
Pulses	Thready	**Cap refill**	3-4 sec	**Skin**	Cool
Airway	Maintained	**Breathing**	Deep breaths (Kussmaul)	**Breath sounds**	Normal
Work of breathing	Normal	**Recession**	Nil	**Neuro**	Alert
Other	Blood ketones = 6 mmol/l				
EXPECTED OUTCOMES					
Participants should:	- Assess ABC - Administer 100% oxygen by facemask - Ask for blood gas and recognise DKA picture - Recognise poor perfusion in context of acidosis - Prescribe fluids: a. 10ml/kg 0.9% saline bolus b. Maintenance + deficit over 48 hours (minus bolus) - Be aware of BPSED fluid calculation sheet and know how to access it online - Prioritise fluid resuscitation over commencement of insulin infusion				
Facilitators should:	<u>Provide further information if requested:</u> Blood/gas results, drug charts, DKA protocol and BPSED documents Blood ketones <u>Progression:</u> - If managed well by junior trainee patient does not deteriorate Progress to **'Resolution of shock and acidosis'** - If suboptimal management e.g. >20ml/kg fluid bolus, bicarbonate, insulin infusion started (or if ST4-8 requiring increased difficulty to challenge participant), patient deteriorates. Progress to **'Cerebral oedema'**				

STATE: RESOLUTION OF SHOCK AND ACIDOSIS

VITAL SIGNS					
Rhythm	SR	**HR**	120	**BP**	90/50
Resp rate	30	**SaO_2**	98%	**$ETCO_2$**	
Temp	37	**AVPU**	A (GCS 15/15)	**Pupils**	4 ERL
Other					
ASSESSMENT					
Pulses	Normal	**Cap refill**	2 sec	**Skin**	Warm, well perfused
Airway	Maintained	**Breathing**	Normal	**Breath sounds**	Normal
Work of breathing	Normal	**Recession**	Nil	**Neuro**	Alert
Other	Blood ketones = 5 mmol/l				
EXPECTED OUTCOMES					
Participants should:	- Reassess ABC - Recognise improving clinical state - Hold off further fluid boluses - Discuss need for HDU admission, and handover to member of HDU team - Give rationale for fluid choice and discuss plan if BM drops too quickly - Recheck blood gas and U+Es 2 hours after resuscitation and then at least 4 hourly. - Suggest hourly neuro observations, hourly BM monitoring, and strict fluid balance (+/- urinary catheterisation)				
Facilitators should:	<u>Provide further information if requested:</u> Repeat blood/gas results Pulse volume, skin temperature and capillary refill normalises <u>Progression:</u> - Move to debrief (see below)				

STATE: CEREBRAL OEDEMA

VITAL SIGNS					
Rhythm	SR	**HR**	80	**BP**	138/60
Resp rate	15	**SaO_2**	85%	**$ETCO_2$**	
Temp	36	**AVPU**	U (GCS 6/15)	**Pupils**	Dilated, sluggish++
Other					

ASSESSMENT					
Pulses	Palpable	**Cap refill**	4 sec	**Skin**	Cool, mottled
Airway	Maintained	**Breathing**	Slowed	**Breath sounds**	Normal
Work of breathing	Normal	**Recession**	Nil	**Neuro**	Unresponsive
Other	Blood ketones = 5 mmol/l				

EXPECTED OUTCOMES	
Participants should:	- Recognise deteriorated neurological state - Call for help (2222) - Reassess ABC - Initiate treatment of cerebral oedema: a. Give hypertonic saline (2.7%) 5ml/kg over 5-10 minutes OR mannitol 0.5-1g/kg over 20 minutes b. Restrict IV fluids to ½ maintenance and replace deficit over 72 hours rather than 48 hours c. Position head up and aim low/normal CO_2. Attempted intubation by inexperienced doctor can lead to transient rise in CO_2 and cardiac arrest due to severe acidosis or worsening of cerebral oedema
Facilitators should:	<u>Progression:</u> - End of scenario once participant handed over the PICU team

APPENDIX 1 – BLOOD GAS – DKA PRESENTATION

RADIOMETER ABL SIMULATION SERIES

ABL725 ICU 11:10 C0 17-12-2012
PATIENT REPORT Syringe - S 195uL Sample# 90396

Identifications

Patient ID	10183365
Patient First Name	Freya
Patient Last Name	Adams
Date of Birth	11/12/2010
Sample type	Venous
Operator	Emergency Department

Blood Gas Values

pH	7.01		[7.340 - 7.450]
*p*CO²	2.40	kPa	[4.70 - 6.00]
*p*O²	6.5	kPa	[10.0 - 13.3]
*p*O²(A-a)e		kPa	

Oximetry Values

*c*tHb	12.9	g/dL	[12.0 - 16.0]
sO²		%	[95.0 - 98.0]
*F*O²Hb		%	[94.0 - 99.0]
FC OHb		%	[-]
*F*HHb		%	[-]
*F*metHb		%	[0.2 - 0.6]
Hct*c*		*%*	

Electrolyte Values

cK+	4.3	mmo1/L	[3.0 - 5.0]
cNa+	128	mmo1/L	[136 - 146]
*c*Ca²+	1.12	mmoq/L	[1.15 - 1.29]
*c*C1-	89	mmo1/L	[98 - 106]

Metabolite Values

*c*Glu	28.2	mmo1/L	[3.5 - 10.0]
*c*Lac	2.5	mmo1/L	[0.5 - 1.6]

Oxygen Status

*c*tO²c		vol%
*p*50c		kPa

Acid Base Status

*c*Base(Ecf)c	-25	mmo1/L
*c*HCO³-(P,st)c	6	mmo1/L

APPENDIX 2 – BLOOD GAS – RESOLUTION OF SHOCK AND ACIDOSIS

RADIOMETER ABL SIMULATION SERIES

ABL725 ICU 11:18 C0 17-12-2012
PATIENT REPORT Syringe - S 195uL Sample# 90396

Identifications

Patient ID	10183365
Patient First Name	Freya
Patient Last Name	Adams
Date of Birth	11/12/2010
Sample type	Venous
Operator	Emergency Department

Blood Gas Values

pH	7.28		[7.340 - 7.450]
*p*CO²	4.2	kPa	[4.70 - 6.00]
*p*O²	6.8	kPa	[10.0 - 13.3]
*p*O²(A-a)e		kPa	

Oximetry Values

*c*tHb	11.5	g/dL	[12.0 - 16.0]
sO²		%	[95.0 - 98.0]
*F*O²Hb		%	[94.0 - 99.0]
FC OHb		%	[-]
*F*HHb		%	[-]
*F*metHb		%	[0.2 - 0.6]
Hct*c*		*%*	

Electrolyte Values

cK+	4.2	mmo1/L	[3.0 - 5.0]
cNa+	131	mmo1/L	[136 - 146]
*c*Ca²+	1.12	mmoq/L	[1.15 - 1.29]
*c*C1-	92	mmo1/L	[98 - 106]

Metabolite Values

*c*Glu	21.2	mmo1/L	[3.5 - 10.0]
*c*Lac	1.9	mmo1/L	[0.5 - 1.6]

Oxygen Status

*c*tO²c		vol%
*p*50c		kPa

Acid Base Status

*c*Base(Ecf)c	-18	mmo1/L
*c*HCO³-(P,st)c	19	mmo1/L

APPENDIX 3 – BLOOD GAS – CEREBRAL OEDEMA

RADIOMETER ABL SIMULATION SERIES

ABL725 ICU 11:10 C0 17-12-2012
PATIENT REPORT Syringe - S 195uL Sample# 90396

Identifications

Patient ID	10183365
Patient First Name	Freya
Patient Last Name	Adams
Date of Birth	11/12/2010
Sample type	Venous
Operator	Emergency Department

Blood Gas Values

pH	6.98		[7.340 - 7.450]
*p*CO²	5.9	kPa	[4.70 - 6.00]
*p*O²	6.3	kPa	[10.0 - 13.3]
*p*O²(A-a)e		kPa	

Oximetry Values

*c*tHb	11.2	g/dL	[12.0 - 16.0]
sO²		%	[95.0 - 98.0]
*F*O²Hb		%	[94.0 - 99.0]
FC OHb		%	[-]
*F*HHb		%	[-]
*F*metHb		%	[0.2 - 0.6]
Hct*c*		*%*	

Electrolyte Values

cK+	4.3	mmo1/L	[3.0 - 5.0]
cNa+	127	mmo1/L	[136 - 146]
*c*Ca²+	1.12	mmoq/L	[1.15 - 1.29]
*c*C1-	100	mmo1/L	[98 - 106]

Metabolite Values

*c*Glu	18.1	mmo1/L	[3.5 - 10.0]
*c*Lac	2.4	mmo1/L	[0.5 - 1.6]

Oxygen Status

*c*tO²c		vol%
*p*50c		kPa

Acid Base Status

*c*Base(Ecf)c	-19	mmo1/L
*c*HCO³-(P,st)c	10	mmo1/L

APPENDIX 4 – BPSED FLUID CALCULATOR (ASSUMPTIONS MADE)

Paediatric Diabetic Ketoacidosis

PATIENT NAME: Freya Adams DATE: 17 Dec 2012

British Society for Paediatric Endocrinology and Diabetes

Diagnosis of DKA = blood glucose >11mmol/L and pH<7.3 bicarb <15 mEq/L
Finger prick blood ketone > 3 mmol/L
Use guideline if >5% dehydrated, vomiting, drowsy or clinically acidotic

MAJOR RISK = CEREBRAL OEDEMA
Aim for slow metabolic correction over 48 hrs

Emergency Management
1) Airway: if coma, insert airway. NGT if coma of vomiting
2) Breathing:give 100% oxygen by face mask
3) Circulation: Insert IV cannula, take blood smaples
4) If shocked, 10ml/kg 0.9% saline bolus, up to 30ml/kg
5) Confirm diagnosis of DKA
6) Investigations: blood glucose, plasma Na, Cl, Ur, Cr

MONITORNG:
1) Strict fluid balance (input / output)
2) Hourly BP and vital signs
3) Hourly blood glucose
4) Blood ketones (1-2 hrly if available)
5) Acid base, plasma Na, K, Cl (4 hrly)
6) 12 hrly weight
7) HDU /PICU if coma, pH<7.1, <1 yr

FLUID THERAPY

Weight	Fluid Maintenance
0 - 12.9 kg	80 ml/kg/24 hrs
13 -19.9 kg	65 ml/kg/24 hrs
20 -34.9 kg	55 ml/kg/24 hrs
35 -59.9 kg	45 ml/kg/24 hrs
> 60 kg	35 ml/kg/24 hrs

Neonates may need 100ml/kg/day

Calculate | Print

Enter patient weight (kg): 15

Degree dehydration (%): 8

Total resus volume (ml): 150

Use 0.9% saline for 1st 12 hrs

Maintenance rate (ml/kg/day)	65ml/kg/day	TOTAL ML PER DAY *	1500
Maintenance volume over 48hrs (ml)	1950	TOTAL (ML/KG/DAY)	100
Rehydration volume over 48hrs (ml)	1200	TOTAL (ML/HOUR)	63
Total fluid /48hrs (ml) minus ressus fluid	3000	TOTAL (ML/KG/HR)	4.2

*Includes subtracting ressus fluid given from total fluid requirement over 48 hrs

INSULIN (Only start infusion after 1st hr of resus fluid)

Add 50 units insulin to 50ml solution of 0.9% saline
(concentration 1 unit/ml, 0.1u/kg/hr = 0.1ml/kg/hr)

Required insulin infusion rate (units/kg/hr): 0.1

Run insulin infusion at 1.5 mls/hr

DO NOT REDUCE insulin rate until ketoacidosis improves
If glucose falls (<14 mmol/L) add Glucose to IVI fluids.

Corrected Na (failure to increase = risk cerebral oedema)

	Sample1	Sample2
Glucose (mmol/L)	28.2	18.1
Plasma Na (mmol/L)	128	127
Corrected Na	134.8	130.8

Fall in corrected Na of -4 mmol/L

Simplified Corrected Na formula
= plasma Na (0.3x (Glu - 5.5)

Corrected Na should rise with therapy (0.5-1mmol/hr)

If associated with falling GCS: consider osmotherapy
1) 5ml/kg of 2.7% saline or
2) 0.5-1 gramm/kg mannitol
3) Consider CT head
4) 2.7% saline can be repeated (even if Na is high)
See www.strs.nhs.uk for information

GLUCOSE CALCULATOR

Size Infusion bag(ml): 500 % Glucose at Start: 5 % Glucose needed: 10

Remove 55.6 mls from bag and replace with 55.6 mls of 50% Glucose

Reference: ESPE/LWPES consensus statement on diabetic ketoacidosis in children and adolescents. Arch Dis Child. 2004 Feb;89 (2):188-94

http://www.bsped.uk

Version 9 – May 2015
Editor: Dr Andrew Darby Smith
Original Author: Dr R Furr (adapted from Bristol Key Competencies)

APPENDIX 5 – EMERGENCY DRUG CHART

Southampton Oxford Retrieval Team

DRUG CALCULATOR

WEIGHT 15 Kg

Enter weight and click calculate

Calculate | Print

Emergency

Adrenaline 1:10,000	1.5 ml	(0.1 ml/kg)
Atropine 600mcg/ml	0.5 ml	(20mcg/kg, min 100mcg)
Atropine 100mcg/ml	3 ml	(20mcg/kg min 100mcg)
Sodium Bicarbonate 8.4%	15 ml	(1 ml/kg)
Calcium Gluconate 10%	7.5 ml	(0.5 ml/kg)

Cardiac

Cardioversion (sync)	15 Joules	(1J/kg) (use 2J/kg if fails)
Shockable rhythm (async)	60 Joules	(4J/kg)
Adenosine	1500 mcg	(100 mcg/kg)
Amiodarone Load	75 mg	(5 mg/kg over 30 minutes to 4hrs)

Neuro

Lorazepam	1.5 mg	(0.1 mg/kg)
Midazolam Buccal	1.5 mg	(0.1 mg/kg)
Phenytoin	300 mg	(20 mg/kg over 20 minutes)
Phenobarbitone	300 mg	(20 mg/kg)
Paraldehyde PR	6 ml	(0.4 ml/kg, mix 1:1 with oil)
3% Saline	45 ml	(3ml/kg)
Mannitol 10%	75 ml	(5ml/kg, eqivalent to 0.5g/kg)

Respiratory

Magnesium Sulphate	600 mg	(40 mg/kg over 20 minutes)
Salbutamol load	225 mcg	(15 mcg/kg over 10 minutes)
Hydrocortisone	60 mg	(4 mg/kg , max 100mg)
Aminophylline load	75 mg	(5 mg/kg over 20 minutes)
Adrenaline 1:1000 Nebulised	5 ml	(0.5 ml/kg, max 5 mls) Make up to 5 ml with saline

Anaesthesia

Ketamine			30 mg	(2mg/kg)
Thiopentone	15	to	75 mg	(1-5mg/kg)
Fentanyl	30	to	75 mcg	(2-5mcg/kg)
Morphine			1.5 mg	(0.1 mg/kg)
Rocuronium			15 mg	(1mg/kg)
Atracurium			7.5 mg	(0.5mg/kg)
Vecuronium			1.5 mg	(0.1mg/kg)
Suxamethonium			22.5 mg	(1.5mg/kg)

Anaphylaxis

Adrenaline IM	0.15 ml of 1:1000

Infusions

Calculations based on Southampton PICU infusions guidelines (2011)

Dopamine (central)	225 mg	in 50ml of 0.9% Saline or 5% Glucose	1 ml / hr	=	5 mcg/kg/min
Dopamine (peripheral)	22.5 mg	in 50ml of 0.9% Saline or 5% Glucose	1 ml / hr	=	0.5 mcg/kg/min
Adrenaline	4.5 mg	in 50ml of 0.9% Saline or 5% Glucose	1 ml / hr	=	0.1 mcg/kg/min
Noradrenaline	4.5 mg	in 50ml of 0.9% Saline or 5% Glucose	1 ml / hr	=	0.1 mcg/kg/min
Milrinone	10 mg	in 50ml of 0.9% Saline or 5% Glucose	2.25 ml / hr	=	0.5 mcg/kg/min
Dinoprostone (Prostin E2)	0 mcg	in 50ml of 0.9% Saline or 5% Glucose	0 ml / hr	=	0 ng/kg/min
Morphine	15 mg	in 50ml of 0.9% Saline or 5% Glucose	1 ml / hr	=	20 mcg/kg/hr
Midazolam	15 mg	in 50ml of 0.9% Saline or 5% Glucose	1 ml / hr	=	20 mcg/kg/hr
Salbutamol	10 mg	in 50ml of 0.9% Saline or 5% Glucose	4.5 ml / hr	=	1 mcg/kg/min
Aminophylline	250 mg	in 250ml of 0.9% Saline or 5% Glucose	15 ml / hr	=	1 mg/kg/hr

It is the prescribers responsibility to ensure the correct dose is prescribed

Compiled by Tom Bennett - May 2012

DEBRIEFING

POINTS FOR FURTHER DISCUSSION

Priority in this case is to treat shock and rehydrate gradually. Blood glucose will have an initial fall with just rehydration. Insulin infusion should be started *after* rehydration commenced. BPSED recommends waiting at least an hour before starting insulin infusion, as there is some evidence that cerebral oedema is more likely if insulin is started early.

Type of fluid for rehydration:

- Initially 0.9% saline with 20 mmol KCl in 500ml
- Once blood glucose has fallen to 14 mmol/l add glucose to the fluid
- After 12 hours, if the plasma sodium is stable or increasing, can change to 0.45% saline with 5% dextrose and 20 mmol KCl.

Corrected sodium levels should rise as blood glucose fall during treatment. If they do not, the continue with 0.9% saline and do not change to 0.45% saline.

Adjust KCl in fluids as required. Serum potassium levels often fall with treatment as insulin drives glucose and potassium into cells via co-transporter channel.

Insulin

Do not start insulin infusion until at least 1 hour after IV fluids started. Run at 0.1 units/kg/hour. Once blood glucose falls below 14mmol, change IV fluids to include 5% dextrose (as well as NaCl and KCl). If continues to fall, change fluids to include 10% dextrose (as well as NaCl and KCl).

Some statistics:

1. In the UK around 70–80% of diabetes related deaths in children under 12 years of age are caused by cerebral oedema
2. Newly diagnosed diabetes is associated with about three times the risk of cerebral oedema associated with previously diagnosed diabetes
3. Although there is no evidence that the risk of cerebral oedema is related to age, sex, or season of occurrence, there was a non-significant trend towards an increased risk in younger patients, who tend to be the most ill at diagnosis
4. Cerebral oedema remains a major complication of DKA with a mortality rate of 25%, and 35% of survivors suffering severe neurological sequelae.

DKA - HANDOUT

INFORMATION FOR PARTICIPANTS

KEY POINTS

Diabetic ketoacidosis is defined by BPSED as:

- Hyperglycaemic (BM>11 mmol/l)
- pH <7.3
- Bicarbonate <14 mmol/l

  AND
- >3% dehydration
- and/or vomiting
- and/or drowsy
- and/or clinically acidotic

Assessment of dehydration:

Mild, 3%	is only just clinically detectable
Moderate, 5%	dry mucous membranes, reduced skin turgor,
Severe, 8%	above with sunken eyes, poor capillary return
+ Shock	May be severely ill with poor perfusion, thready rapid pulse. Reduced blood pressure is not likely and is a very late sign.

Over-estimation of degree of dehydration is dangerous. Therefore do not use more than 8% dehydration in calculations

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Corrected sodium levels should rise as blood glucose fall during treatment. If they do not, the continue with 0.9% saline and do not change to 0.45% saline. (Adjust KCl in fluids as required. Serum potassium levels often fall with treatment as insulin drives glucose and potassium into cells via co-transporter channel).

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Some statistics:

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4. Cerebral oedema remains a major complication of DKA with a mortality rate of 25%, and 35% of survivors suffering severe neurological sequelae.

FURTHER RESOURCES

The risk and outcome of cerebral oedema developing during diabetic ketoacidosis.
Edge JA, Hawkins MM, Winter DL, Dunger DB: *Arch Dis Child* **85** : 16 –22,2001
http://adc.bmj.com/content/85/1/16.abstract?ijkey=3f14927d288c6d3d0890d5bde9bfe865e77e6abb&keytype2=tf_ipsecsha

NHS choices patient information on DKA
http://www.nhs.uk/conditions/diabetic-ketoacidosis/Pages/Introduction.aspx

Clinical guideline from BPSED(British Society for Paediatric Endocrinology and Diabetes)
http://www.bsped.org.uk/clinical/docs/DKAGuideline.pdf

Fluid calculator for DKA from BPSED
http://www.bsped.org.uk/clinical/docs/DKACalculator.pdf

SORT (Southampton Oxford Retrieval Team) guideline for hypertonic saline – see below
http://www.sort.nhs.uk/Media/Guidelines/Hypertonicsaline3sodiumchlorideguideline.pdf

Hypertonic saline (3% NaCl) guideline

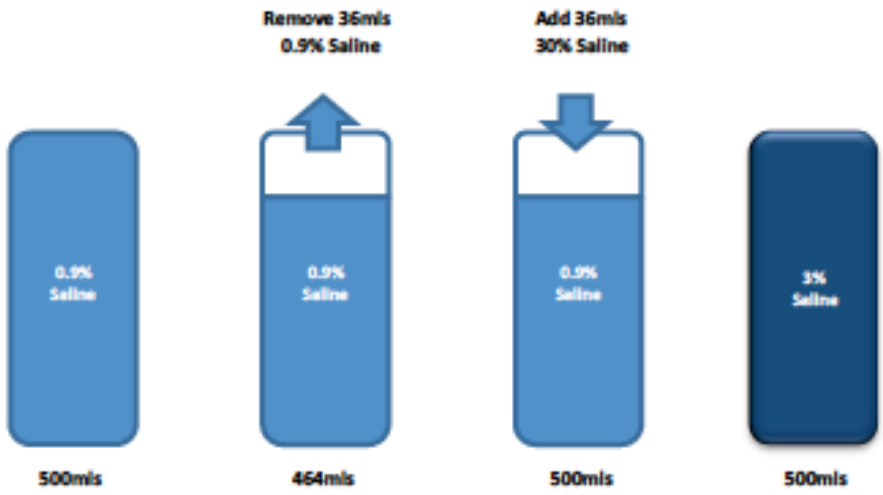
Indications for use of 3% NaCl
- **Cerebral oedema** and raised ICP (e.g. head injury, DKA)
- **Hyponatraemic seizures**

Mechanism of action
- Increases plasma sodium
- Creates an osmotic gradient
- Induces a shift of fluid from the intracellular to the extracellular space
- Reduces brain water
- Increases effective circulating volume

3% NaCl versus Mannitol
- As effective for the treatment of raised ICP in traumatic brain injury
- Less "rebound" ICP
- No obligatory osmotic diuresis (plasma volume preserved/expanded)
- Mannitol may be nephrotoxic
- 3% NaCl is reno-protective.
- Monitoring osmolality
  - For 3% NaCl one can use plasma Na
  - For mannitol need to infer osmolar gap

Dose of 3% NaCl (or pre-made 2.7% NaCl when available)
- Cerebral oedema (TBI or DKA) standard dose is **3-5 mls/kg** (over 10–20 minutes)
- For seizures associated with acute hyponatraemia use aliquots of **1ml/kg** to raise the **Na to ≥125 mmol/L**
- Use SAME dose even if the pre-made 2.7% NaCl solutions is used
- Repeat as clinically indicated
- 3mls/kg of 3% saline will **increase plasma Na by approximately 2-3 mmol/L.** The increase may be greater if a large diuresis occurs. Check plasma Na if any doubt

PREPARATION OF 3% NaCl USING 30% NaCl (to make 500mls)



PREPARATION OF 3% NaCl USING 30% NaCl (to make 50mls)
Take 5 ml NaCl 30%
Dilute with 45ml water for injection to give a final volume of 50ml and mix well

DO NOT CONNECT THE 500ML BAG OF 3% SALINE DIRECTLY TO PATIENT IV LINE (RISK OF SERIOUS SODIUM OVERDOSE IF FULL BAG ACCIDENTALLY INFUSED). ALWAYS WITHDRAW THE PRESCRIBED VOLUME OF 3% SALINE (e.g. 3mls/kg) AND ADMINSTER TO PATIENT SEPARATELY

RELEVANT AREAS OF THE CURRICULUM

Level One

L1_GEN_STA_02	Effective responses to challenge, complexity and stress in paediatrics
L1_GEN_STA_03	Advanced neonatal and paediatric life support skills
L1_GEN_STA_05	Effective skills in paediatric assessment
L1_GEN_STA_06	Skills in formulating an appropriate differential diagnosis in paediatrics
L1_GEN_STA_07	Effective initial management of ill-health and clinical conditions in paediatrics seeking additional advice and opinion as appropriate
L1_GEN_STA_09	Safe practical skills in paediatrics
L1_GEN_STA_15	Knowledge of common and serious paediatric conditions and their management
L1_GEN_STA_29	Effective communication and interpersonal skills with colleagues
L1_GEN_STA_30	Professional respect for the contribution of colleagues in a range of roles in paediatric practice
L1_GEN_STA_32	Effective handover, referral and discharge procedures in paediatrics
L1_GEN_STA_34	Ethical personal and professional practice in providing safe clinical care
L1_GEN_STA_35	Reliability and responsibility in ensuring their accessibility to colleagues and patients and their families
PAED_L1_ENDO_ACU_DKA_01	Understand the pathophysiology of diabetic ketoacidosis
PAED_L1_ENDO_ACU_DKA_02	Be aware of potential complications of DKA including cerebral oedema
PAED_L1_ENDO_ACU_DKA_03	Know how to treat and monitor progress in DKA
PAED_L1_ENDO_ACU_DKA_04	Be able to recognise the clinical features of DKA
PAED_L1_ENDO_ACU_DKA_05	Be able to lead the team when initiating resuscitation and early treatment of DKA
PAED_L1_ENDO_ACU_DKA_06	Be able to manage ongoing treatment of DKA safely with guidance
PAED_L1_NEURO_GCS_02	Understand the principles of treatment (of altered GCS)

Level Two (as above plus):

L2_GEN_STA_02	Increasing credibility and independence in response to challenge and stress in paediatrics
L2_GEN_STA_03	Leadership skills in advanced neonatal and paediatric life support
L2_GEN_STA_04	Responsibility for conducting effective paediatric assessments and interpreting findings appropriately
L2_GEN_STA_06	Improving skills in formulating an appropriate differential diagnosis in paediatrics
L2_GEN_STA_09	Effective skills in performing and supervising practical procedures in paediatrics ensuring patient safety

L2_GEN_STA_15	Extended knowledge of common and serious paediatric conditions and their management
L2_GEN_STA_29	Skill in ensuring effective relationships between colleagues
L2_GEN_STA_32	Effective skills in ensuring handover, referral and discharge procedures in paediatrics
L2_GEN_STA_34	Sound ethical, personal and professional practice in providing safe clinical care
L2_GEN_STA_35	Continued responsibility and accessibility to colleagues, patients and their families
PAED_L2_ENDO_ACU_DKA_01	Recognise potential complications of DKA including cerebral oedema

Level Three (as above plus):

L3_GEN_STA_02	Responsibility for an effective response to complex challenges and stress in paediatrics
L2_GEN_STA_03	Leadership skills in advanced neonatal and paediatric life support
L3_GEN_STA_06	Effective skills in making safe decisions about the most likely diagnoses in paediatrics
L3_GEN_STA_07	Leadership skills in the management of common and complex conditions in general paediatrics and paediatric subspecialties seeking additional advice and opinion as appropriate
L3_GEN_STA_09	Expertise in a range of practical procedures in paediatrics specific to general and sub-specialist training
L3_GEN_STA_15	Detailed knowledge of common and serious paediatric conditions and their management in General Paediatrics or in a paediatric sub-specialty
L3_GEN_STA_29	Positive and constructive relationships form a wide range of professional contexts
L3_GEN_STA_32	Effective leadership skills in the organisation of paediatric team-working and effective handover
L3_GEN_STA_34	Exemplary professional conduct so as to act as a role model to others in providing safe clinical care
L3_GEN_STA_35	Responsibility for ensuring their own reliability and accessibility and that of others in their team
PAED_L3_ENDO_ACU_DKA_01	Be able to manage ongoing treatment safely within guidelines (DKA)

PARTICIPANT REFLECTION

What have you learned from this experience? (Please try and list 3 things)

How will your practice now change?

What other actions will you now take to meet any identified learning needs?

PARTICIPANT FEEDBACK

Date of training session:.....

Profession and grade:.....

What role(s) did you play in the scenario? (Please tick)

Primary/Initial Participant	
Secondary Participant (e.g. 'Call for Help' responder)	
Other health care professional (e.g. nurse/ODP)	
Other role (please specify):	
Observer	

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
I found this scenario useful					
I understand more about the scenario subject					
I have more confidence to deal with this scenario					
The material covered was relevant to me					

Please write down one thing you have learned today, and that you will use in your clinical practice.

How could this scenario be improved for future participants? This is especially important if you have ticked anything in the disagree/strongly disagree box.

FACULTY DEBRIEF – TO BE COMPLETED BY FACULTY TEAM

What went particularly well during this scenario?

What did not go well, or as well as planned?

Why didn't it go well?

How could the scenario be improved for future participants?