Diabetic emergencies

RCEM Annual Scientific Conference
2016
20, 21 and 22 September 2016
Bournemouth International Centre
What Diabetic emergencies used to be

- Hypoglycaemia
- Diabetic Ketoacidosis
  - Type 1, young patients
- Hyperosmolar Non-ketotic coma (HONK)
  - Type 2, older patients with co-morbidities.
Hypoglycaemia

RESULTS—A total of 279,937 patients experienced 302,095 hospitalizations for hyperglycaemia, and 404,467 patients experienced 429,850 hospitalizations for hypoglycaemia between 1999 and 2011. During this time, rates of admissions for hyperglycaemia declined by 38.6% (from 114 to 70 admissions per 100,000 person-years), while admissions for hypoglycaemia increased by 11.7% (from 94 to 105 admissions per 100,000 person-years). In analyses designed to account for changing diabetes mellitus prevalence, admissions for hyperglycaemia and hypoglycaemia declined by 55.2% and 9.5%, respectively. Trends were similar across age, sex, and racial subgroups, but hypoglycaemia rates were 2-fold higher for older patients (≥75 years) when compared with younger patients (65–74 years), and admission rates for both hyperglycaemia and hypoglycaemia were 4-fold higher for black patients compared with white patients. The 30-day and 1-year mortality and 30-day readmission rates improved during the study period and were similar after an index hospitalization for either hyperglycaemia or hypoglycaemia (5.4%, 17.1%, and 15.3%, respectively, after hyperglycaemia hospitalizations in 2010, 4.4%, 19.9%, and 16.3% after hypoglycaemia hospitalizations).

- Type 1 and Type 2 diabetes
- Related to management of glycaemia
- Underlying cardiovascular disease
- Many episodes occur at night
But............. Hyperglycaemia emergencies
No longer classified as DKA and HONK

- Better understanding
- More complex
- Changing population
  - More type 2
  - Younger type 2
  - More obesity
DKA – Diabetic Ketoacidosis
HHS – Hyperglycaemia, Hyperosmolar syndrome
# Diabetic Ketoacidosis (DKA)

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Admissions to Hospital with DKA has remained constant (7,500 - 8,500 admissions per year).

In children, 40% newly diagnosed diabetes mellitus present with DKA
  - younger age increases this risk.

Women x2 more likely as men to be admitted

Most patients with DKA have Type 1 DM

Recurrent DKA accounts for 15% of cases
  - more common in patients who are socially deprived, poorly educated or those with learning difficulties
Management of Diabetic Ketoacidosis

IV Fluids

Assess volume status of patient

Severe dehydration

Suggested regimen
- NaCl 0.9% initially
  - 1 l in 30 mins
  - 1 l in 1 hour
  - 1 l in 2 hours
  - 1 l in 4 hours
  - 1 l in 6 hours

Mild dehydration

In patients with less severe DKA, hydration with NaCl 0.9% at 500 ml/h for 4 hours followed by 250 ml/h for 4 hours then fluids as required, may be sufficient

This should be varied according to clinical need. Colloids may be used initially as required

Patients may require invasive monitoring and inotropic support if in shock or if DKA complicated by severe comorbidity

Insulin

Intravenous bolus
- Soluble insulin 6 – 10 units

Continuous infusion
- (50 units of soluble insulin in 50 ml 0.9% NaCl to give 1 unit per ml)
- Begin infusion at 0.1 unit/kg/hr
- Aim to decrease glucose by 3–5 mmol/l/h
- If glucose does not decrease by > 3 mmol/l/h in first 1 hour repeat bolus
- Maintain insulin infusion at > 2 U/h until ketones are cleared. 5% glucose may be required as the hyperglycaemia is corrected.
- Aim to maintain glucose 8 – 11 mmol/l until DKA resolved.

Potassium

Begin fluid resuscitation without delay but potassium replacement will be required

Check K+ on admission
- Aim for K+ 4 – 5 mmol/l
- If K+ < 4 mmol/l replace 40 mmol/l NaCl 0.9%
- If K+ 4 – 5.5 mmol/l replace 20 mmol/l NaCl 0.9%
- Check K+ at least every 2 hours
- Withhold K+ if patient is anuric or if K+ > 5.5 mmol/l, continue to check every 2 hours

Uncomplicated mild DKA may be managed with subcutaneous soluble insulin
- 0.3 units/kg initially
- 0.2 units/kg 1 hour later
- 0.2 units/kg every 2 hours

Hexokinase: No clear indication for using NaHCO3 to correct pH. May be used (100 ml 8.4% NaHCO3) if pH < 6.9 and impending cardiac or respiratory collapse. Monitor potassium and calcium carefully.

Phosphate: Patients with DKA have a phosphate deficit. Replacement has not been shown to confer a benefit but may be indicated in severe hypophosphataemia (phosphate < 0.33 mmol/l) or in patients with anaemia, cardiac dysfunction or respiratory failure. Care must be taken to avoid hypocalcaemia
Change in emphasis

• Routine used of ketometers
• Ketones end markers, not glucose

Joint British Diabetes Societies in-patient care group recommendations 2013: Management of DKA
Joint British Diabetes Societies in-patient care group recommendations 2013: Management of DKA

- **Reduction of blood ketone** concentration by 0.5 mmol/h
- Increase venous bicarbonate concentration by 3 mmol/L/h
- Reduce capillary blood glucose by 3.0 mmol/L/h
- **No bolus** dose of insulin
- Maintain Potassium at 4.0 – 5.5 mmol/L

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<th>WEIGHT in KG</th>
<th>INSULIN DOSE PER HOUR (Units)</th>
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<td>60-69</td>
<td>6</td>
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<td>80-89</td>
<td>8</td>
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<td>90-99</td>
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<tr>
<td>&gt;150</td>
<td>15 (any dose higher than this should be on the advice of the Diabetes Specialist Team)</td>
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Start a fixed rate insulin infusion (FRIII) based on 0.1 units/kg/h
Continue patient’s normal subcutaneous insulin regimen
Increase the insulin infusion rate according to Ketone response or if no ketometer available, titrate to bicarbonate concentration.
Fluid management in DKA

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<td>0.9% sodium chloride 1L</td>
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*Potassium chloride may be required if more than 1 litre of sodium chloride has been given already to resuscitate hypotensive patients.

Re-assessment of cardiovascular status at 12 hours is mandatory, further fluid may be required.

Caution in children and young adults
Death from DKA

- Mortality should be < 5%
  - majority of deaths occur amongst the elderly or patients with significant co-morbidities and intercurrent illnesses.

- In children, DKA itself remains a common cause of death
  - 0.15 – 0.3% of children with DKA dying
  - Cerebral Oedema
DIAGNOSIS:
Ketonaemia ≥ 3.0mmol/L or significant ketonuria (more than 2+ on standard urine sticks)
Blood glucose > 11.0mmol/L or known diabetes mellitus
Bicarbonate (HCO₃⁻) < 15.0mmol/L and/or venous pH < 7.3
Hyperosmolar Hyperglycaemia Syndrome (HHS)

**Definition and diagnosis**

A precise definition of HHS does not exist and would be inappropriate, but there are characteristic features that differentiate it from other hyperglycaemic states such as DKA. These are:

- Hypovolaemia
- Marked hyperglycaemia (30 mmol/L or more) without significant hyperketonaemia (<3 mmol/L) or acidosis (pH > 7.3, bicarbonate > 15 mmol/L)
- Osmolality usually > 320 mOsm/kg or more

_N.B. A mixed picture of HHS and DKA may occur._

Often!
# HHS and mixed presentations

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HHS or HHS with Ketones

- Type 2 patients
- Tend to be older but this trend is changing...
- Risk factors
  - Ethnicity – Black patients
  - Obesity
- HHS with Ketones not new...but increasing in frequency
  - idiopathic type 1 diabetes,
  - Flatbush diabetes,
  - atypical diabetes
  - ketosis-prone type 2 diabetes
- Co-morbidities
Failure of insulin production

Hyperglycaemia

Increased Ketones

Precipitating event / inadequate insulin intake

Increased: Glucagon, Cortisol, Catecholamines, Growth hormone

Peripheral insulin resistance

Gluconeogenesis

Increased:
- Glucagon
- Cortisol
- Catecholamines
- Growth hormone

Ketone production

Severe dehydration

Electrolyte depletion

Hyperosmolality

Decreased glucose utilisation

Glycogenolysis

Proteolysis

Peripheral tissues

Amino acids

Adipocytes

Lipolysis

Increased Ketones

Severe metabolic Acidosis / DKA

Precipitating event / inadequate insulin intake

Glycosuria

Severe Dehydration
Electrolyte depletion
Hyperosmolality

DKA ➔ HHS
# Deficits in hyperglycaemic crises

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<th>HHS (Deficit for 70kg)</th>
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<td>Water (ml/kg)</td>
<td>100 (7 l)</td>
<td>100 – 200 (7 – 14 l)</td>
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<td>Na⁺ (mmol/kg)</td>
<td>7 – 10 (490 – 700)</td>
<td>5 – 13 (350 – 910)</td>
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<td>K⁺ (mmol/kg)</td>
<td>3 – 5 (210 – 350)</td>
<td>4 – 6 (280 – 420)</td>
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<td>Mg²⁺ (mmol/kg)</td>
<td>0.5 – 1 (35 – 70)</td>
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<td>Ca²⁺ (mmol/kg)</td>
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Osmolality

• Normal Osmolality
  ▫ 275–295 mosm/kg (mmol/kg)

• Measured in the lab

• Calculated
  ▫ \(2\text{Na}^+ + \text{glucose} + \text{urea}\)
  ▫ \(2(\text{Na}^+ + \text{K}^+) + \text{glucose}\)
  ▫ \(2\text{Na}^+ + \text{glucose}\)
Sodium in HHS

- **Serum Sodium concentration**
  - Can be low, normal or high on presentation

  - **But**
    - Overall total body deficit of 5-13 mmol/kg \( (350 - 910 \text{ mmol in 70kg man}) \)

- Regardless of serum sodium....these patients have a total body sodium deficit
Patient: 35 yrs old, BMI > 35, ethnicity - black, first presentation.

- Presentation to A&E
  - Confused (GCS 14/15)
  - Blood glucose 90 mmol/L
  - Sodium 115 mmol/L, K+ 5.0 mmol/L
  - Calculated osmolality 330 mosmol/L

- Young with 2+ Ketones in Urine.........therefore DKA!!!!!
  - Given Insulin bolus and infusion + NaCl ++++
  - Blood glucose 20 mmol/L
  - Serum sodium 145 mmol/L
  - Osmolality 310 mosmol/L
  - GCS 3/15

- Died: Coned in A&E
Movement of Water

Dehydrated cell

Net movement of water out of cells down osmotic gradient

Insulin lack/resistance no uptake of glucose by cells

Na⁺ concentration diluted by movement of water

Net movement of water into cells down gradient generated idiogenic osmoles

On administering insulin, glucose is rapidly taken up by cells and Na⁺ concentration increased due to movement of water.

Glucose

H₂O

Na⁺

Build up of idiogenic osmoles within cells may include increased intracellular sodium

Hydrated cell/oedema

Net movement of water into cells down gradient generated idiogenic osmoles

On administering insulin, glucose is rapidly taken up by cells and Na⁺ concentration increased due to movement of water.

Glucose

H₂O

Na⁺
In children with DKA

- Cerebral Oedema is the main cause of death
  - Immature blood brain barrier (BBB)

- Increased survival with incremental increases in Na
  - Unproven in adults
What Next?

BUT WHAT IF I DON'T WANT TO BE FUNDAMENTALLY TRANSFORMED...??

[Cartoon image]
The management of the hyperosmolar hyperglycaemic state (HHS) in adults with diabetes

Joint British Diabetes Societies Inpatient Care Group

August 2012
Patient 52, BMI 32, new onset DM, ethnicity - white

• Presentation
  ▫ GCS 13/15
  ▫ Na⁺ 130 mmol/L, K⁺ 4.5 mmol/L
  ▫ Glucose 70 mmol/L
  ▫ Osmolality – 349 mosmol/L

• Resuscitation started, NaCl 0.9%, no insulin
  ▫ GCS 14/15
  ▫ Na⁺ 158 mmol/L, K⁺ 3.5 mmol/L
  ▫ Glucose 40 mmol/L
  ▫ Osmolality – 363 mmol/L
Admit to HDU

- Calculate osmolality to monitor therapy

- An initial rise in Sodium is to expected.
  - THERE IS NO PLACE FOR HYPOTONIC FLUIDS TO CORRECT THE SODIUM
  - NaCl 0.9% will cause hyperchloremia, significance unknown

- 0.9% NaCl, maximum 3 – 6 litres in first 12 hours.
  - If anything err towards less...this took days to develop
Insulin therapy

- Glucose levels should decrease at $\leq 5$ mmol/L/h
  - **NO INSULIN** SHOULD BE GIVEN INITIALLY.....if ever!
  - Insulin is *only indicated if ketones persist* or if correction of glucose with fluids alone stalls
  - Once corrected maintain blood glucose 10 – 15 mmol/L – Give 10% glucose to achieve this
  - Insulin at a **maximum of 0.05U/kg/h** when/if indicated
Management cont’d

- Allow the patient to drink free fluids when able
- Assessment of conscious level frequently
- Look for underlying precipitants
- Anticoagulation
- Feet
Thank you
### Insulin and Time to Presentation

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